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Mechanical Properties of Concrete with Partial Replacement of Bagasse Ash

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Abstract — *The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economical, environmental, and technical reasons. Sugar-cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapor. This waste product (Sugar-cane Bagasse ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse ash mainly contains aluminum ion and silica. In this paper, Bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken was well as hardened concrete tests like compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of seven and 28 days was obtained. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased.*

Keywords- *bagasse ash, compressive strength, split tensile strength and flexural strength*

I. INTRODUCTION

1.1. CONCRETE

Concrete is the most extensively used construction material in the world and is the second to water as the most heavily consumed substance with about six billion tons produced every year. It has emerged as the dominant construction material for the infrastructure needs of the 21stcentury. The challenge for civil engineers in the future is to design the project using high performance materials within reasonable cost and lower impact on environment. Large quantities of waste materials are produced from the manufacturing industry, service industry and municipal solid waste incinerators. The waste materials are gaining attention to use the materials as a substitute to natural aggregates or cement in concrete.

Ordinary Portland cement is recognized as a major construction material throughout the world. Portland cement is the conventional building material that actually is responsible for about 5% - 8% of global CO2 emissions. This environmental problem will most likely be increased due to exponential demand of Portland cement.

Initiatives are developing worldwide to control and regulate the supervision of sub-products, residuals and industrial wastes in order to preserve the environment from contamination. A good solution to the problem of recycling agro industrial excess would be by burning them in a controlled environment and use the ashes (waste) for more polite means. Utilization of such wastes as cement and fine aggregate replacement materials may reduce the cost of concrete production and also minimize the harmful environmental effects with disposal of these wastes. Sugarcane is one of the foremost crops grown in all over countries and its entire production is over 1500 million tons. After the extraction of all efficient sugar from sugarcane, large fibrous excess is obtained. When bagasse is burnt in the boiler of cogeneration plant under controlled conditions, sensitive amorphous silica is formed due to the combustion process and is present in the remaining ashes known as Sugarcane Bagasse Ash. This amorphous silica content makes bagasse ash as a useful cement replacement material in concrete. Each ton of sugarcane produces around 25.65% of bagasse (at a moisture content of 50%) and 0.61% of residual ash.

The excess after combustion presents a chemical composition controls by silicon dioxide (sio2). From the past investigates it is found that the bagasse ash comprises of the properties of nature sand. But these ashes are produced under unrestrained and non-uniform burning conditions with temperatures rising above 1000°c resulting in a manifestation of the matter .In this study the bagasse ash is planned to use as the partial replacement for cement and fine aggregate in-order to utilize the wastages and to protect the atmosphere from the hazards. Sugarcane bagasse ash is normally used as manure in sugarcane plantation.

1.2. BAGASSE ASH

The sugarcane bagasse consists of approximately 50% of cellulose,25% of hemicellulose and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (SiO_2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests. In this sugarcane bagasse ash was collected during the cleaning operation of a boiler operating in the Sakthi Sugar Factory, located in the city of Sathyamangalam, Tamilnadu.

II.MATERIALS AND METHODS

2.1.CEMENT

A building material made by grinding calcites limestone and clay to a fine powder, which can be mixed with water and poured to set as a solid mass or used as an ingredient in making mortar or concrete. Ordinary Portland Cement (53 grade) Coromandel cement conforming to IS 8112 was used. The different laboratory tests were conducted on cement to determine standard consistency, initial and final setting time as per IS 269-1967. The results conforms to the IS recommendations. The fineness of the cement will be calculated by sieve analysis through which the certain amount of cement is retained on 90mm sieve i.e., about 4%. The cement has been tested for various proportion as per IS 4031-1988 and found to be confirming to various specifications of IS 12269-1987. Sp. gravity of cement is given as per table 1.

Table 1. Properties of cement

S.no	Properties	Results
1.	Specific Gravity	3.12
2.	Standard Consistency	35%
3.	Initial Setting Time	30mins
4.	Final Setting Time	600mins

2.2.COARSE AGGREGATE

Crushed angular granite metal of 12.5 mm size from a local source was used as coarse aggregate. The specific gravity of 2.7 and water absorption of 0.5 %.Coarse aggregate is gravel which has been crushed, washed and sieved so that the particles vary from 12.5 mm to 50 mm. Those particles, which size varies from 12.5 mm to 20 mm is known as coarse aggregates. Coarse aggregate properties given as per table 2.

Table 2. Properties of Coarse aggregate

S.n	**Properties**	**Results**
1.	Impact value	15.2%
2.	Specific Gravity	2.68
3.	Dry Density	1680Kg/m^3
4.	Water Absorption	0.5 %

2.3.FINE AGGREGATE

Aggregate are sieved to remove particles larger than 4.75 mm. Those particles which are between 2 mm to 4.75 mm is termed as fine aggregates. Fig. 3.2 shows fine aggregates used in this project. The specific gravity of 2.65 and water absorption of 1.5 %. Fine aggregate properties given as per table 3.

Table 3 properties of Fine aggregate

S.no	Properties	Results
1.	Specific Gravity	2.60
2.	Dry density	1600 Kg/m^3
3.	Absorption	1.5%

2.4.BAGASSE ASH

Sugarcane is an important food crop for tropics and subtropics. It is the major raw materials used for sugar production. Sugarcane bagasse (SCB) is the waste produced after juice extraction from sugarcane. The Sugarcane bagasse ash (SCBA) is obtained as by product of control burning of sugarcane bagasse. SCBA constitutes an environmental nuisance as they form refuse heaps in areas they are disposed.

Table 4 properties of Bagasse ash

S.no	Properties	Results
1.	Specific Gravity	1.8
2.	Dry density	400 Kg/m^3
4.	porosity	66%

Cement

Coarse aggregate

Fine aggregate

Bagasse ash

Figure 1. Ingredients of Bagasse Concrete

III. MIX DESIGN

Mix design was done using IS method of mix design for M30 Concrete. The mix proportion arrives is as follows

Table 5 Mix proportion

Cement Kg/m^3	Fine Aggregate Kg/m^3	Coarse Aggregate Kg/m^3	W/C Ratio Kg/m^3
492.9	712.15	1004.7	197.16
Ratio 1	: 1.44	: 2.04	: 0.4

III . RESULTS AND DISCUSSION

3.1. Compressive Strength

The compression strength is the capacity of a material or structure to withstand loads tending to reduce size. It can be measured by plotting applied force against deformation in a testing machine. The cube, cylinder and beam will get fractured at their compressive strength limit. And the given amount of deformation may be considered as the limit for compressive load. The relevant photographs during the testing of concrete are given in Figure.2. The compressive strength of the all the four mixes at 7, 14 and 28 days are shown in table.6, 7 and 8 respectively. The 10% replaced Bagasse concrete exhibits higher strength than the control mix and it is slightly more than the control concrete. The compressive strength of concrete is calculated using the formula below.

$$\text{Compressive strength} = \frac{\text{LOAD}}{\text{AREA}} \text{ in N/mm}^2$$


Concrete for cating


Concrete Cubes


Curing of concretecubes


Testing of concrete cube

Figure 2. Concrete Cubes

Table 6. Compressive strength at 7 days

S.NO	Replacement of Cement	Compressive Strength (N/mm^2)
1	Control concrete	26.32
2	5 %	19.32
3	10 %	26.78
4	15 %	19.24

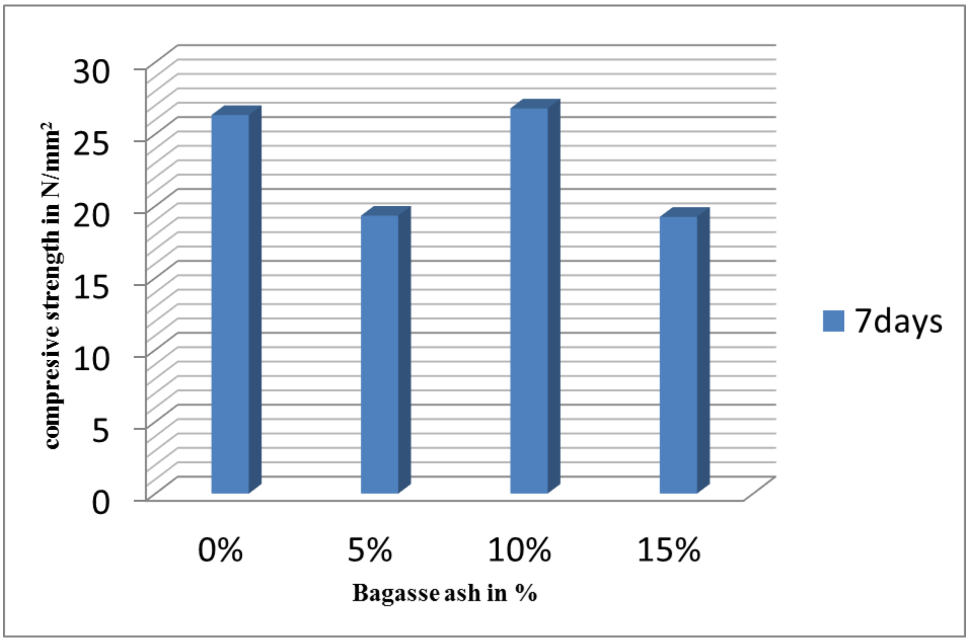

Table 7. Compressive strength at 14 days

S.NO	Replacement of Cement	Compressive Strength (N/mm^2)
1	Control concrete	31.11
2	5 %	24.22
3	10 %	32.77
4	15 %	22.8

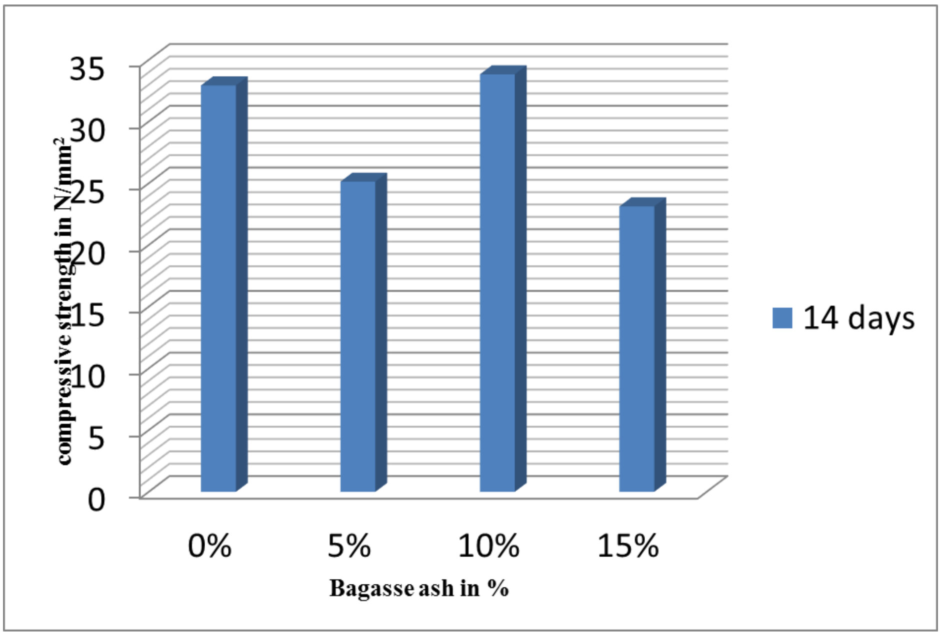

Table 8. Compressive strength at 28 days

S.NO	Replacement of Cement	Compressive Strength (N/mm^2)
1	Control concrete	36.88
2	5 %	27
3	10 %	37.55
4	15 %	26.11

3.2. Spilt Tensile Strength

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The test set up for split tensile strength is shown in fig.3. The split tensile strength of the all the four mixes are shown in table.9. The 10% replaced Bagasse concrete exhibits higher strength than the control mix and it is slightly more than the control concrete. The split tensile strength of concrete is calculated using the formula below.

$$\text{Tensile strength} = \frac{2P}{\pi D L} \text{ in } N/mm^2$$

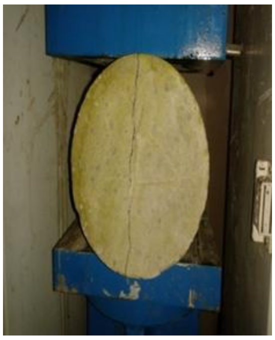

Figure 3. Split tensile strength test

Table.9. Split Tensile Strength

S.NO	Replacement of Cement	Tensile Strength (N/mm^2) 7 days	Tensile Strength (N/mm^2) 14 days	Tensile Strength (N/mm^2) 28 days
1	Control concrete	3.50	4.25	4.21
2	5 %	2.48	3.27	3.53
3	10 %	3.6	4.30	4.5
4	15 %	2.3	3.15	3.10

3.3. Flexural strength

The bending test was conducted on the beam using deflection test apparatus. The dimension of the beam is 500 mm Length, 100mm width and 100mm depth. Nine samples were tested for 7days, 14days, 28days.Adjust the apparatus to have 1 m span, place the load hanger at the center of the span. Place the deflectometer at the place where deflection is to be measured at the center. Place the load in the hanger in steps of 50gm from zero and note the deflection reading for every load increment. The test set up is shown in Figure 3. The flexural strength of control concrete and bagasse replaced concretes are shown in table10. The concrete replaced with 10 % of bagasse ash exhibits maximum flexural strength and it is slightly more than the control concrete at all age of concrete. The flexural strength of concrete is calculated using the following formula.

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$$\text{Flexural strength } (N/mm^2) = \frac{PL}{BD^2} \text{ in } N/mm^2$$

Figure 3. Flexural Strength Test

Replacement of cement	Flexural Strength (N/mm^2) 7 days	Flexural Strength (N/mm^2) 14 days	Flexural Strength (N/mm^2) 28 days
Control	3.5	4.5	4.7
5 %	2.5	3.25	3.8
10 %	3.25	4.6	4.8
15 %	2.6	3.4	3.7

IV. CONCLUSION

The experimental result shows that the increase in the strength of concrete can be achieved by replacing 10 % of bagasse ash by the weight of cement. The increase in strength maybe due to the pozzzolonic properties of bagasse ash.

Though the increase in strength is very minimum, the cost reduction of concrete can be achieved due to the 10 % less consumption of cement in the concrete. Using bagasse as replacement of in concrete, the emission of greenhouse gases can be reduced due to less production of cement.

The spilit tensile strength of control concrete and bagasse concrete are around 10 % of the corresponding compressive strength of concrete, which resembles it is similar to conventional concrete. The results indicate that bagasse ash can be used as a pozzolanic material in concrete with an acceptable strength, lower heat evolution, and reduced water permeability with respect to the control concrete. Also the environment can be kept clean as land filling of bagasse is avoided.

REFERENCES

1. Nan su Kung-chunghsu, His-wen chai. (2001). A simple mix design method for Self compacting concrete. Cement and Concrete Research.31: 1799 -1809.

2.Ganesan N., Indira P.V. and Santhosh Kumar P.T. (2003).State of art report on Self Compacting Concrete Proceedings of International Conference INCONTEST2003, held at Kumaraguru College of Technology. pp.348-354.

3.JagdishVengala, Sudarshan M.S. and Ranganath R.V. (2003). Experimental study for obtaining self-compacting concrete. The Indian Concrete Journal.August. pp.1261- 1266.\

4.Kewalramani, M.A.; Gupta, R, (Dec 18-19, 2003). Annamalainagar."Experimental study of concrete strength through an eco-friendly curing technique," Advances in concrete technology and concrete structures for the future.

5. JagdishVengala and Ranganath R.V. (2004). Mixture proportioning procedures for self-compacting concrete. The Indian Concrete Journal.August. pp. 13-21.

6. Amit Mittal, Kaisare M.B. and Shetty R.G.(2004). Use of SCC in a pump house at TAPP 3 and 4, Tarapur the Indian Concrete Journal. June. Pp. 3034.

7. Bapat S.G, Kulkarni S.B. and Bandekar K.S. (2004). Using SCC in nuclear power plants-Laboratory and mock-uptrials at Kaiga. The Indian Concrete Journal. June. pp. 51-57.

8. Sahmaran Christianto Yaman. (2006). The effect of chemical admixture sand mineral additives on the properties of self-compacting mortars. Cement and Concrete Composites. 28: 432-440.

9. IS 516-1959 (Reaffirmed 1999). Indian Standard code of practice for Method of tests for strength of concrete. Bureau of Indian Standards, New Delhi.

10. IS 12269-1982. (Reaffirmed 2004). Indian Standard specifications for 53grade ordinary Portland cement. Bureau of Indian Standards, New Delhi.

11. IS 10262-1982. (Reaffirmed 2004). Indian Standard code of practice fore commended guidelines for concrete mix design. Bureau of Indian Standards, New Delhi.

